WAVETEK

OPERATOR'S MANUAL

HD153, 222F, 223F

Digital Multimeters

WARNINGS AND PRECAUTIONS

PLEASE READ SECTION II—SAFETY INFORMATION AND SECTION VI— SPECIFICATIONS REGARDING "WARNINGS AND PRECAUTIONS."

Exceeding the maximum limits of this instrument is DANGEROUS.

Exceeding these limits will expose you to physical injury or even death and will almost certainly damage your instrument. Even low-level voltages and currents are capable of causing serious injury or even death.

Please do not use this or any piece of test equipment without proper training. Individual functions and ranges have different overload limits. It is VERY IMPORTANT that you make yourself aware of these overload limits. Check the specifications of these overload limits. Check the specifications in SECTIONS II and III for specific overload limits.

WAVETEK

OPERATOR'S MANUAL

HD153, 222F, 223F Digital Multimeters

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Manual Part Number 1000-0386-01B

Warranty

HD153 Series 5-Year Limited Warranty Against Contamination

Heavy Duty HD153 Multimeters are warranted against all accidental contamination for five (5) years from the date of purchase. Wavetek will repair or replace any HD153 DMM which is damaged due to contamination entering the case.

Warranty Against Defects

HD153, 222F, and 223F multimeters are warranted all defects of material or workmanship which develop for any reason whatsoever, except abuse, within a period of three (3) year from the date of purchase of by the original buyer. This warranty is extended only to the original buyer or original user of the multimeter, who must present proof of purchase at the time of warranty service.

In the USA any multimeter claimed to be defective during the warranty period should be returned with proof of purchase to an authorized Wavetek Corp. Factory Service Center. Follow the shipping instructions as detailed in the service section at the back of this manual. For warranty repair outside the USA, contact your local Wavetek dealer, or distributor where your multimeter was purchased, or return it to an authorized Wavetek Corp. Factory Service Center.

ANY IMPLIED WARRANTIES ARISING OUT OF THE SALE OF A WAVETEK MULTIMETER, INCLUDING BUT NOT LIMITED TO IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO THE ABOVE STATED PERIODS. WAVETEK SHALL NOT BE LIABLE FOR LOSS OF USE OF THE MULTIMETER OR OTHER INCIDENTAL OR CONSEQUENTIAL DAMAGES, EXPENSES, OR ECONOMIC LOSS OR FOR ANY CLAIM OR CLAIMS FOR SUCH DAMAGE, EXPENSES OR ECONOMIC LOSS.

Some states do not allow limitations on how long implied warranties last or the exclusion or limitation of incidental or consequential damages, so the above limitations or exclusions may not apply to you.

This warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

Wavetek Corporation

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Section I Introduction

1.1 Introduction

Congratulations! You have purchased one of the finest autoranging digital multimeters available. Your Wavetek multimeter will give you years of reliable service. Your new meter is easy to use but, because of its many innovative features, please read the safety information and operating instructions before use.

1.2 Features

Autorange/Manual Range Modes
The HD153, 222F, and 223F feature fast autoranging for all measurement ranges.

- Press the range button to go to manual range mode. Flashing symbols (e.g., Ω) show that you are in the manual range mode. Press the range button as required to select the desired range.
- To switch back to autorange, press the ***ON/C*** button once (clear mode) or select another function.

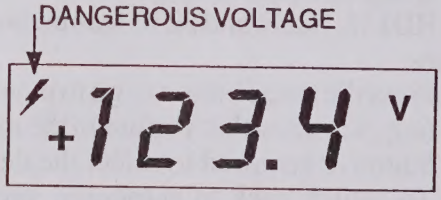
Compact, Tough Design
HD153, 222F, and 223F meters feature compact design for easy handling. Both feature a tough, internally braced case with rounded corners and edges and total overload protection for all functions and ranges. Special heavy duty features of the HD150 Series include a fully gasketed case that is waterproof, fire-retardant, and resistant to mild solvents.

Audible Readout (HD153 and Model 223F)
The audible readout feature produces a tone with a pitch proportional to the measurement's magnitude. This feature lets you detect intermittents, and perform peaking, nulling and other operations with varying trends or levels without having to look at the meter (see pages 21-22). Audible readout can be used for any function except diode test.

- Press the ⏦/⎍⎍ button to activate the audible readout mode.
- Press the ***ON/C*** button (clear mode) to deactivate audible readout.

Automatic Off (Battery Saver)
The meter turns itself off after one hour of nonuse (during which no button is pressed, no function selected and no range selected). While turned off, current draw does not affect battery life. If the meter turns off while a parameter is being monitored, press the ***ON/C*** button to turn it on again. To protect against electrical damage, the meter also turns itself off if a test lead is inserted into the ***10A*** jack while the meter is in any mode other than ***A*** ⎓ or ***A*** ∿.

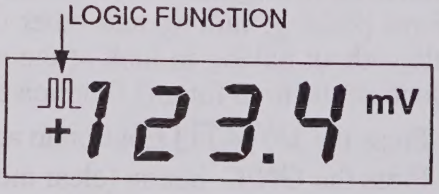
Dangerous Voltage Indication
The meter shows the ϟ symbol for voltage ranges over 20V. In autoranging mode, the meter beeps when it changes to any range over 20V.



Caution
Exercise extreme caution when the meter displays the ϟ symbol.

Logic Function (HD153 and Model 223F)
Logic pulses are easily detected with the logic function—the meter beeps for pulses above +2.6V, up to 25 pulses per second. Above 25 pulses per second, a continuous tone is produced.

- To use the logic function, select ***V*** ⎓, then press the Hz/⎍⎍ button twice. The meter displays ⎍⎍ to indicate that the logic function is enabled.
- To return to the normal autoranging mode, press the ***ON/C*** button once (clear mode).



Tilt Stand/Skyhook™

The Tilt Stand/Skyhook allows the meter to stand up on a level surface or to hang from a nearby projection, leaving your hands free. For the the Model 222F, use the two existing screws in the upper back of the case to attach the optional Tilt Stand/Skyhook assembly to the back of the meter, as shown in Figure 1 (the Tilt Stand/Skyhook comes already installed on the HD153 and Model 223F).

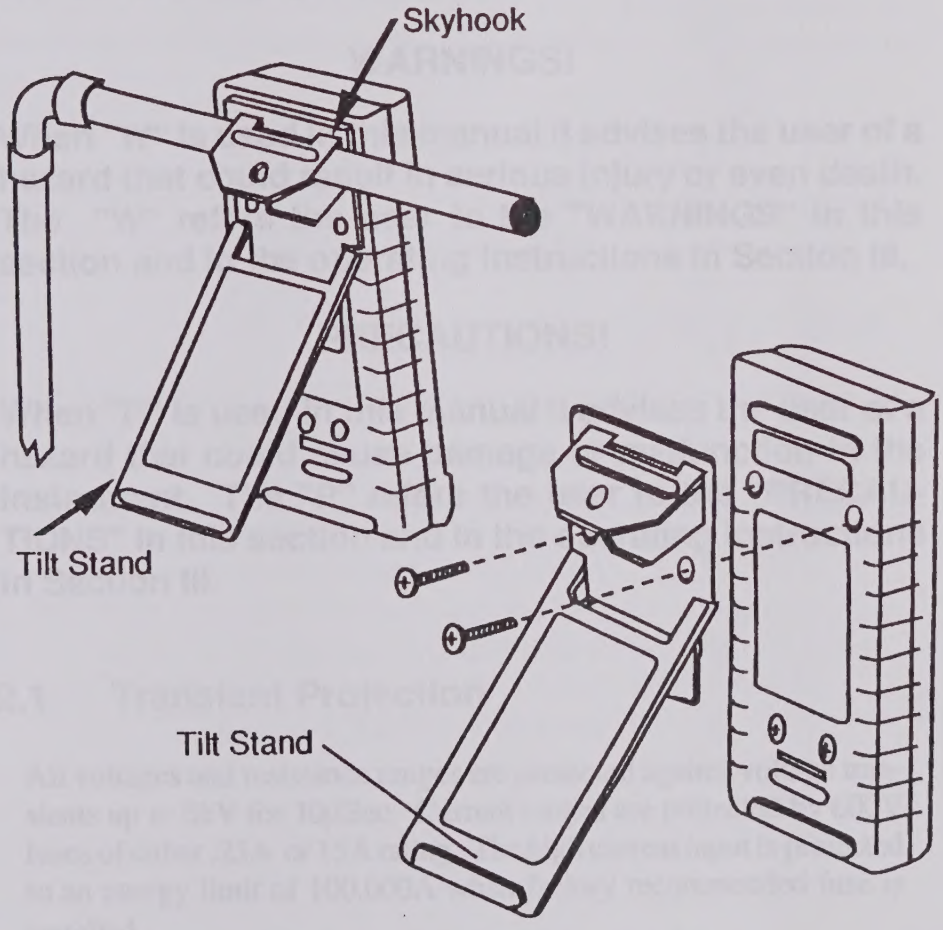


Figure 1. Tilt Stand/Skyhook™

Skyhook is a registered trademark of Wavetek Corporation

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Section II Safety Information

This manual contains important safety information and warnings which must be followed in order to ensure safe operation and to protect you, the user, from serious injury or death.

WARNINGS!

When "W" is used in this manual it advises the user of a hazard that could result in serious injury or even death. The "W" refers the user to the "WARNINGS" in this section and in the operating instructions in Section III.

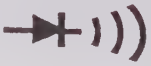
PRECAUTIONS!

When "P" is used in this manual it advises the user of a hazard that could cause damage or malfunction in the instrument. The "P" refers the user to the "PRECAUTIONS" in this section and in the operating instructions in Section III.

2.1 Transient Protection

All voltages and resistance ranges are protected against voltage transients up to 6kV for 10μSec. Current ranges are protected by 600V fuses of either .25A or 15A rating. The high current input is protected to an energy limit of 100,000A when factory recommended fuse is installed.

2.2 Symbol Explanation

	Attention! Refer to the Operating Instructions
	Dangerous Voltage May Be Present at Terminals
	AC — Alternating Current
	DC — Direct Current
	Audible Readout
	Logic Function
	**Diode Test/Continuity Function**
V	**Volt (Voltage) Function**
A	**Ampere (Current) Function**
Ω	**Ohm (Resistance) Function**

2.3 Warnings

"W" Since injury or death can occur even with low voltages, exercise *extreme caution* when measuring: voltage above 20V, AC mains with inductive loads, or measuring AC mains during electrical storms.

Measuring a voltage which exceeds the meter limits may damage the instrument and expose the user to a dangerous shock. The limits are listed on the meter:

HD153:	VDC: max 1500V
	VAC: max 1000V
	max 1500V between any terminal and earth ground.
222F, 223F:	VDC: max 1000V
	VAC: max 750V
	max 1000V between any terminal and earth ground.

Inspect the test leads and all insulation for damage before each use. DO NOT USE IF DAMAGED.

To avoid shock, do not touch the probe tips or circuit under test while power is applied.

"W" Both the low and high current jacks are protected by fuses; however, to avoid damage or injury, use only in circuits limited to 20A and a maximum of 600V.

"W"
"P"

Warnings and Precautions

Do not attempt to measure voltages or currents that may exceed the ratings marked on the Function/ Range Switch or terminal overlays.

Use extreme caution when working near high voltage sources. This includes any voltage measurements requiring the use of the two highest VAC or VDC ranges.

To avoid electrical shock hazard and/or damage to the multimeter, do not measure voltages that might exceed the maximum voltage rating above earth ground.

Operator injury or damage to the multimeter may occur during current measurements if the fuse blows in a circuit which exhibits an open circuit voltage greater than 600 volts.

Before each use of the multimeter, inspect test leads, connectors, and probes for cracks or breaks in the insulation. If any defects are found, replace item immediately.

To avoid electrical shock hazard, do not touch test leads, tips, or the circuit being tested while power is applied to the circuit being measured.

"P"

Exceeding the maximum input overload limits can damage the multimeter.

When measuring current, check that the multimeter is connected in series with the load in which the current is to be measured. NEVER connect the multimeter ACROSS a voltage source. To do so can result in either blowing the overload protection fuse or damaging the device being tested.

"W" "OL" Indicates that the meter's maximum voltage or current input level has been exceeded. Remove the test probes from the circuit immediately.

Inspect the test leads and all insulation for damage before each use. DO NOT USE IF DAMAGED.

To avoid shock, do not touch the test probe tips or circuit under test while power is applied.

Voltage Measurements

"W"
"P"CRT SERVICE REMINDER: A POTENTIAL DANGER TO YOU AND YOUR METER EXISTS WHEN MEASURING VOLTAGES IN THE HORIZONTAL OUTPUT AND DAMPER STAGES OF CRT EQUIPMENT. THIS DANGER IS CAUSED BY THE HIGH VOLTAGE TRANSIENTS (GREATER THAN 6,000 VOLTS) THAT OCCUR IN THESE CIRCUITS. PLEASE REFER TO YOUR CRT SERVICE MANUAL FOR PROPER SERVICING INSTRUCTIONS.

Section III Operation

3.1 Audible Acknowledgement

The meter acknowledges each press of a button or actuation of the selector switch with a beep.

3.2 On/Clear Button

- Press ***ON/C*** to turn the meter on—operation begins in the auto-range mode and the range for maximum resolution is selected automatically. Press the ***ON/C*** button again to turn the meter off.
- In the Range Lock, Variable Tone, or Logic Mode, press the ***ON/C*** button once to clear the mode, or twice to turn the meter off.

3.3 Overload Indication

"P"

Range overload is indicated by "OL" in display. This is normal in the OHMS range when the leads are not connected to anything. In all other situations, the user must take immediate steps to remove the cause of the overload condition from the instrument.

The meter displays OL and a rapidly flashing decimal point (position determined by range) when the input exceeds the meter's measurement range.

3.4 Measuring Voltage (See hookup diagram, page 13)

CRT Service Safety Reminder

A POTENTIAL DANGER TO YOU AND YOUR METER EXISTS WHEN MEASURING VOLTAGES IN THE HORIZONTAL OUTPUT AND DAMPER STAGES OF CRT EQUIPMENT. THIS DANGER IS CAUSED BY THE HIGH VOLTAGE TRANSIENTS (GREATER THAN 6,000 VOLTS) THAT OCCUR IN THESE CIRCUITS. PLEASE REFER TO YOUR CRT SERVICE MANUAL FOR PROPER SERVICING INSTRUCTIONS.

Select $V\overline{\overline{\overline{\ }}}$ or $V\sim$ function. Connect test leads as shown. Observe voltage reading on display. Depending on the range, the meter displays units in mV or V.

"W"

To avoid shock hazard or meter damage, do not apply more than the following voltages between any meter input jack and earth ground:

HD153: 1500VDC or peak AC
222F, 223F: 1000VDC or peak AC

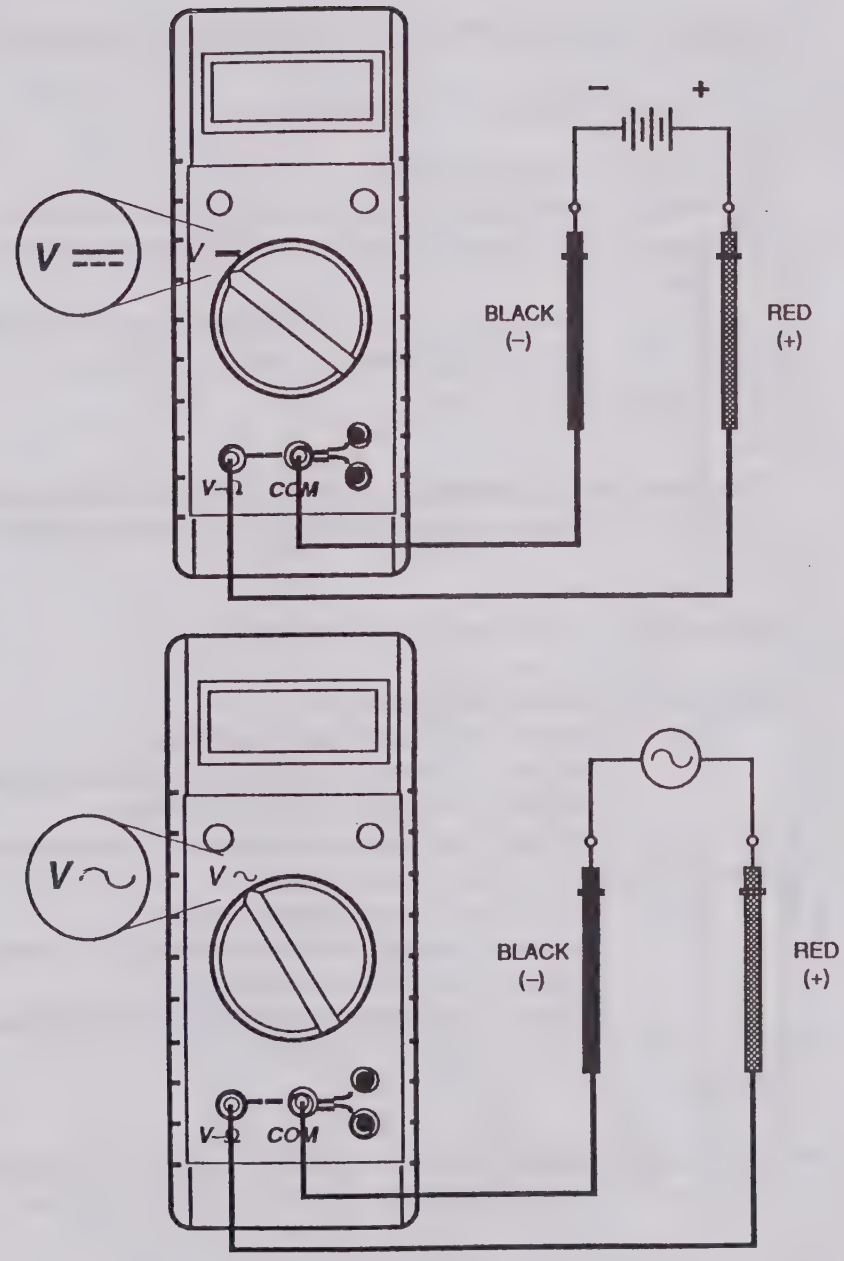


Figure 2. Voltage hookups

3.4 Measuring Current (hookup diagrams on pages 15-16)

Select the ***A*** ⎓ or ***A*** ∿ function.

① Disconnect current source.
② Break circuit at point where current is to be measured.
③ Insert meter in series with circuit with the red lead connected to the...

...***200mA*** jack for input currents up to 200 milliamps, or
...***10A*** jack for input currents up to 10 amps.

④ Apply current to load.

"W" **To avoid meter damage, caution is needed when measuring currents of 5A or greater, especially in warm environments:**	
Temperature	**Max Current Measurements**
<100°F (38°C)	**<5A: continuous use is ok.** **5A to 10A: 3 minutes maximum.** **Allow 10 minutes cool-down before continuing.** **10A to 20A: 30 seconds maximum.** **Allow 2 minutes cool-down before continuing.**
>100°F (38°C)	**<5A: continuous use is ok.** **5A to 10A: 1 minute maximum.** **Allow 5 minutes cool-down before continuing.** **10A to 20A: 30 sec maximum.** **Allow 5 minutes cool-down before continuing.**

NOTE: The meter shuts itself off if a test lead is inserted into the ***10A*** jack when the meter is in any function other than ***A*** ⎓ or ***A*** ∿.

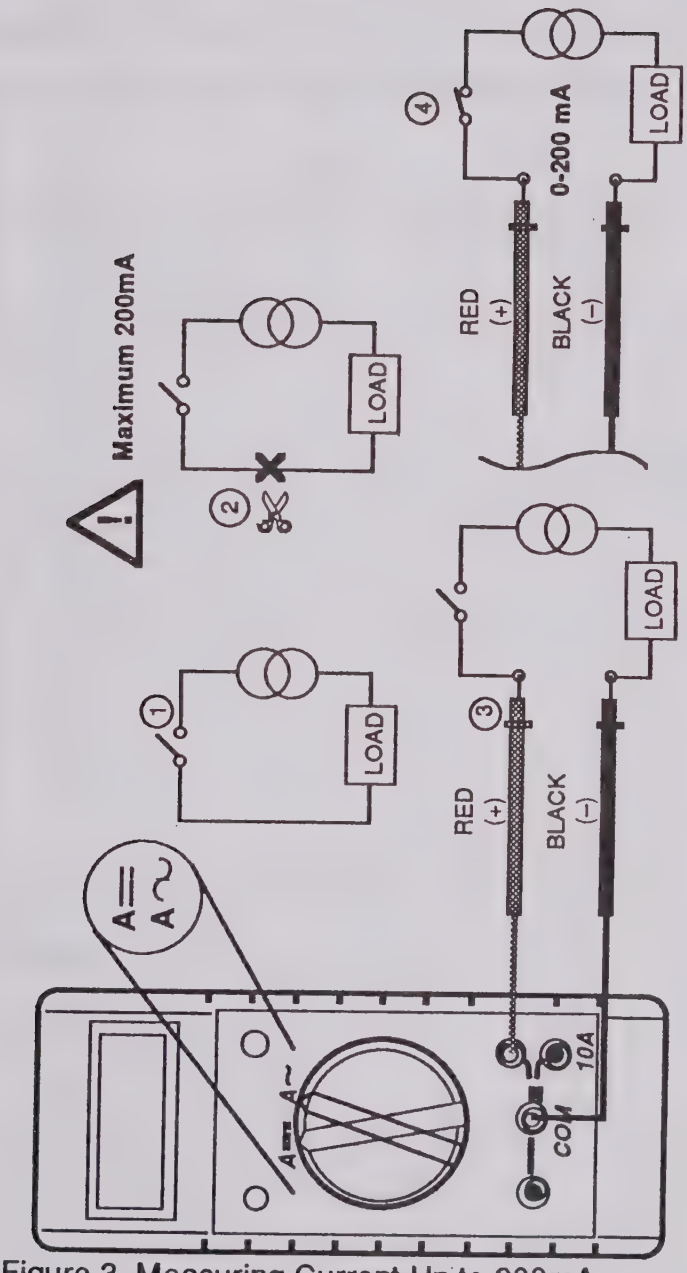


Figure 3. Measuring Current Up to 200mA

see warnings on page 12

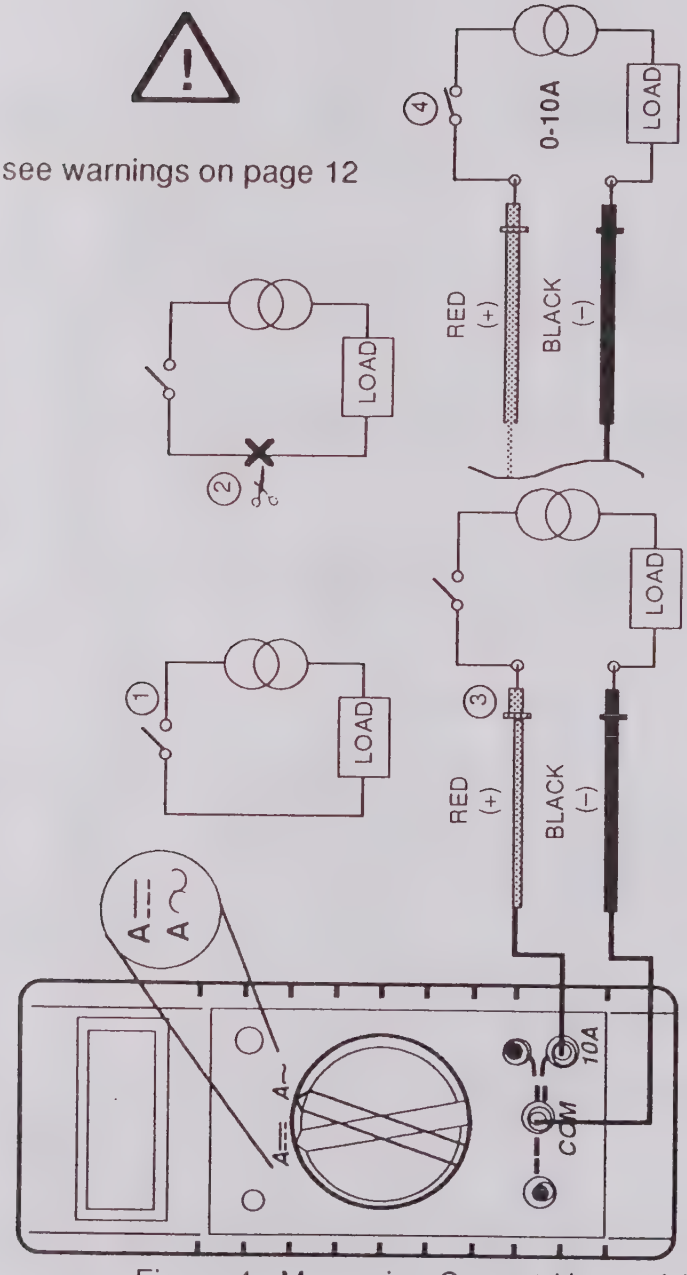


Figure 4. Measuring Current Up to 10A

3.5 Measuring Resistance (hookup diagram on page 18)

Select the Ω (Ohms) function. Connect the test leads as shown.

Note

Discharge any capacitors in the circuit before taking a resistance measurement. Any voltage present will cause incorrect readings.

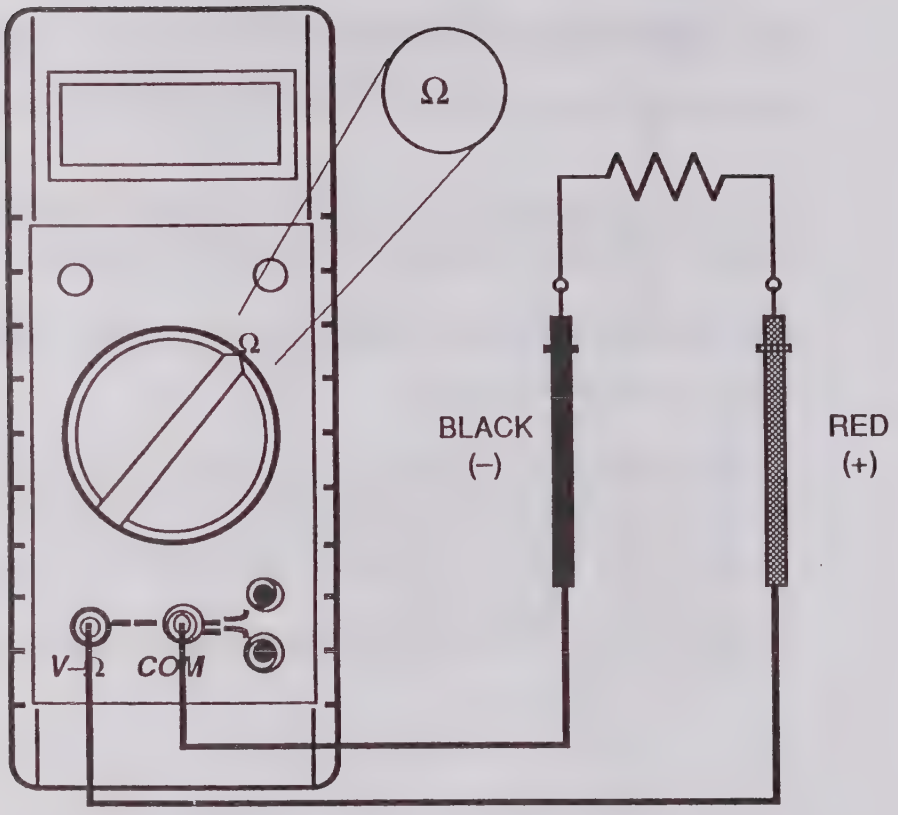
3.6 Diode/Continuity Test (hookup diagram on page 19)

Select the →+•)) function.

Ⓐ Forward bias: Connect to diode as shown. Display shows forward voltage drop (V_F) of a good diode (≤0.7V), a very low reading for a shorted diode (<0.3V), or OL for an open diode.

Ⓑ Reverse bias or open circuit: Reverse leads to diode—meter displays OL, no beep.

Ⓒ Continuity: The meter beeps once if circuit resistance is less than 150 Ohms.



In-circuit measurements: Discharge capacitors before measuring resistance.

Figure 5. Resistance Measuring Hookup

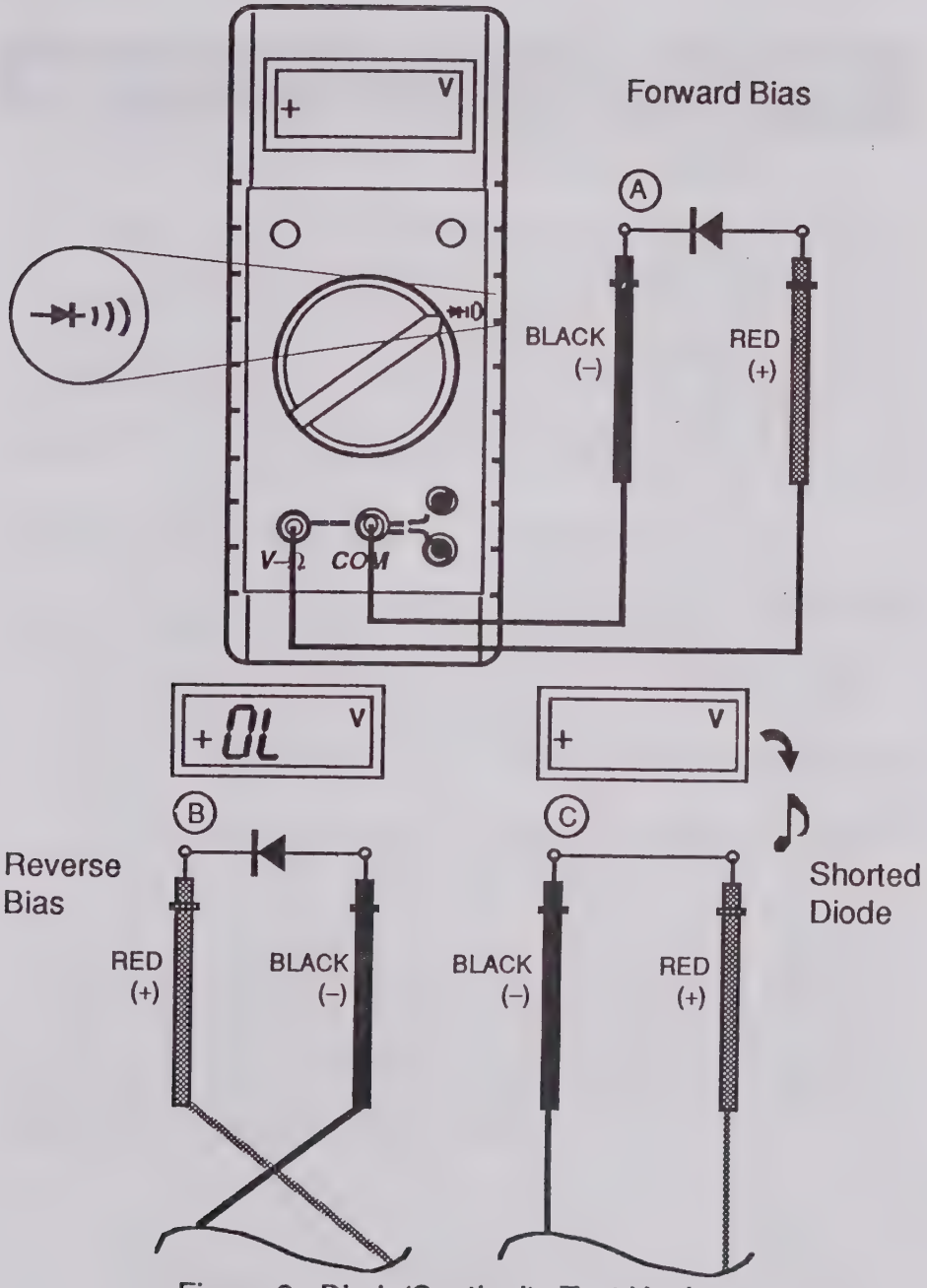


Figure 6. Diode/Continuity Test Hookup

Section IV Applications

4.1 Intermittent Detection (HD153 and Model 223F)

Use the audible readout to find intermittent components, connections or circuits. Activate the Audible Readout (press the button once. Measure **V**, Ω, or **A** at a suitable point. While listening to the meter, induce the intermittent condition (systematically moving components or cooling/heating suspect components or connections, see page 22). A steady tone indicates a normal condition, such as stable voltage. An unsteady or crackling sound indicates an intermittent part or connection.

4.2 Capacitor Test (HD153 and Model 223F)

Capacitors can easily be functionally tested using audible readout mode (press the button once) with a manually selected Ω range:

- Select the appropriate resistance range for the capacitor being checked. Refer to the chart on page 23.
- Discharge the capacitor being checked by briefly shorting its leads together.
- Connect the meter to the capacitor as shown in diagram on page 23. *Observe proper polarity for polarized capacitors.*

Upon connection, the meter emits a tone sweeping from low to high frequency, then stops if the capacitor is good; this means the capacitor is accepting a charge (resistance reading rises from short to OL). A continuous slow clicking sound indicates a *shorted* capacitor (low or zero ohms reading). No tone indicates an *open* capacitor (OL reading). A continuous tone indicates a *leaky* capacitor.

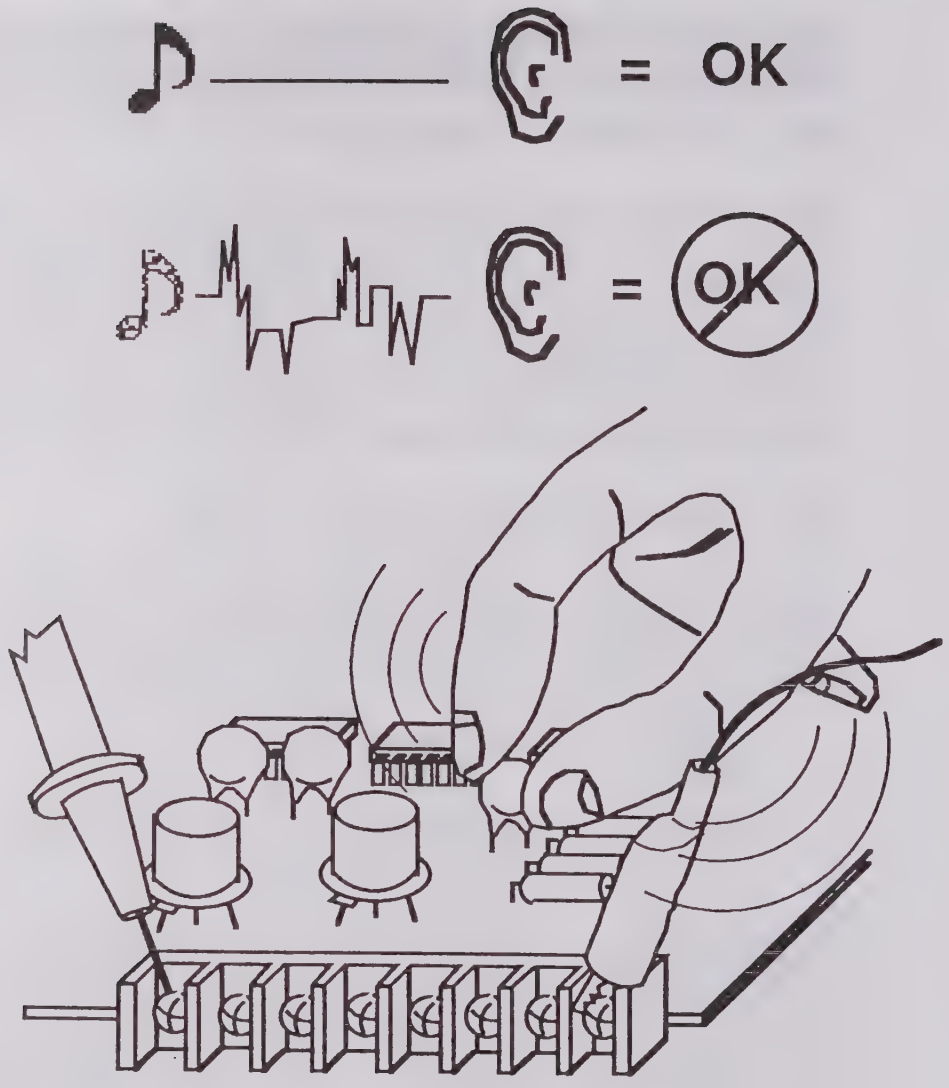
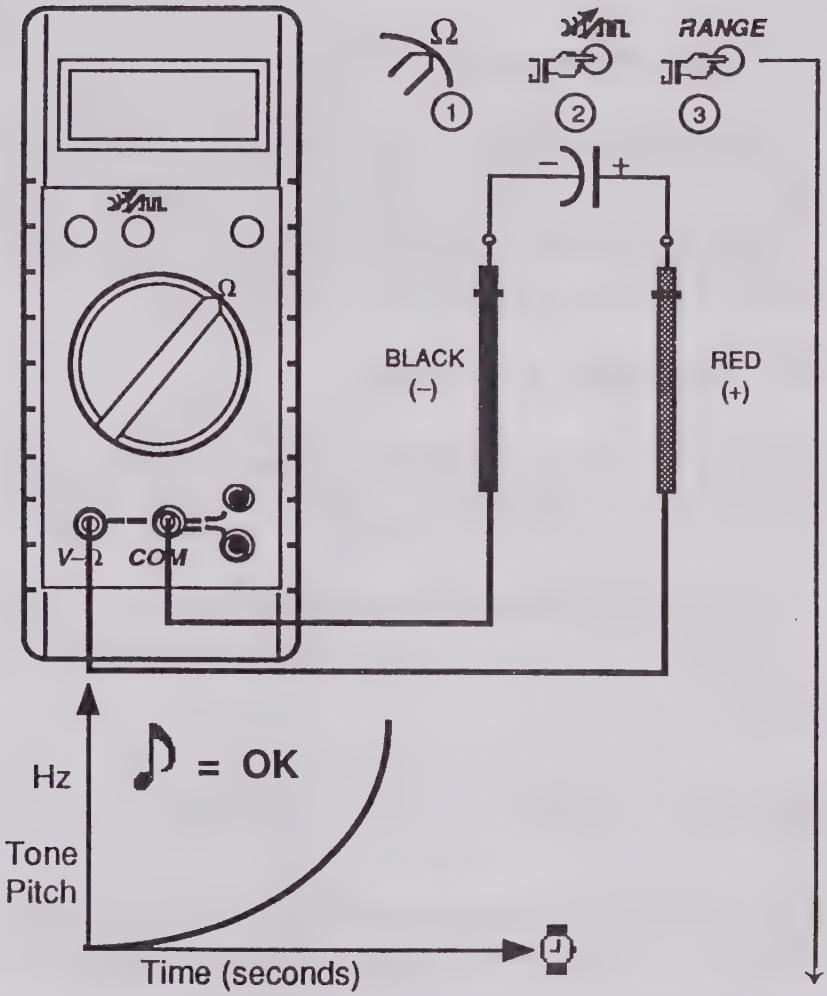


Figure 6. Checking Intermittents



Capacitor Value	Meter Range (display)	Display, Leads Open
0.001 to 0.01µF	20M (19.99M)	O.L M
0.01 to 1µF	2M (1.999M)	.OL M
0.1 to 1µF	200k (199.9k)	OL. K
1 to 10µF	20k (19.99k)	O.L K
10 to 100µF	2k (1.999k)	.OL K
100 to 4700µF	200 (199.9)	OL.

Figure 7. Capacitor Test Hookup

4.3 Transistor Junction Test

Test transistors in the same manner as diodes by checking the two diode junctions formed between the base and emitter, and the base and collector of the transistor. Figure 8 shows the orientation of these effective diode junctions for PNP and NPN transistors. Also check between the collector and emitter to determine if a short is present.

4.4 Transistor Beta Test

Use the multimeter to determine DC current gain (beta) of a transistor. This is done by making a simple test fixture (see Figure 9) and using the meter's Diode Test function as follows:

1. With all connections made to the test fixture as shown on page 25, and with switch S1 open, record the displayed reading (ignore decimal point).

Note

If an overload indication is obtained, reverse the connections to the multimeter.

If an overload indication is obtained regardless of meter orientation, or if a reading less than 0.200 is obtained, the transistor is probably defective.

2. Close switch S1—record the new displayed reading (ignore decimal point).
3. Divide 2000 by the difference in digits between the readings obtained in steps 1 and 2. The resulting number is the DC beta of the transistor.

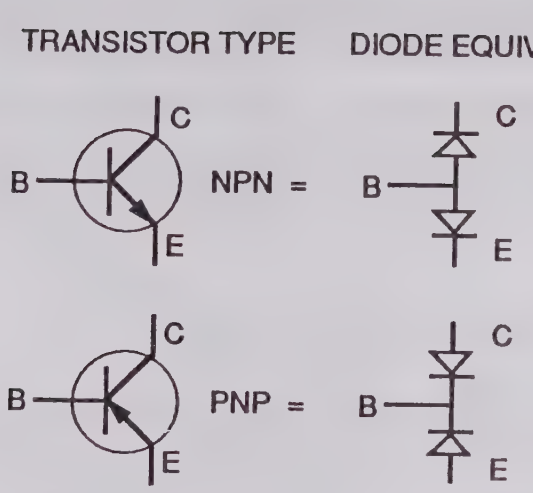


Figure 8. Transistor Junction Test

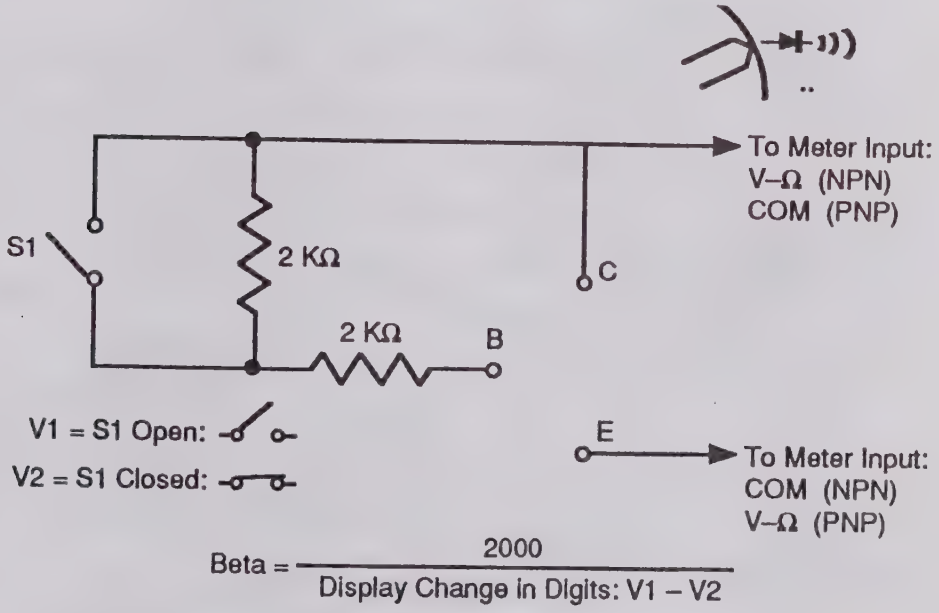


Figure 9. Transistor Beta Test

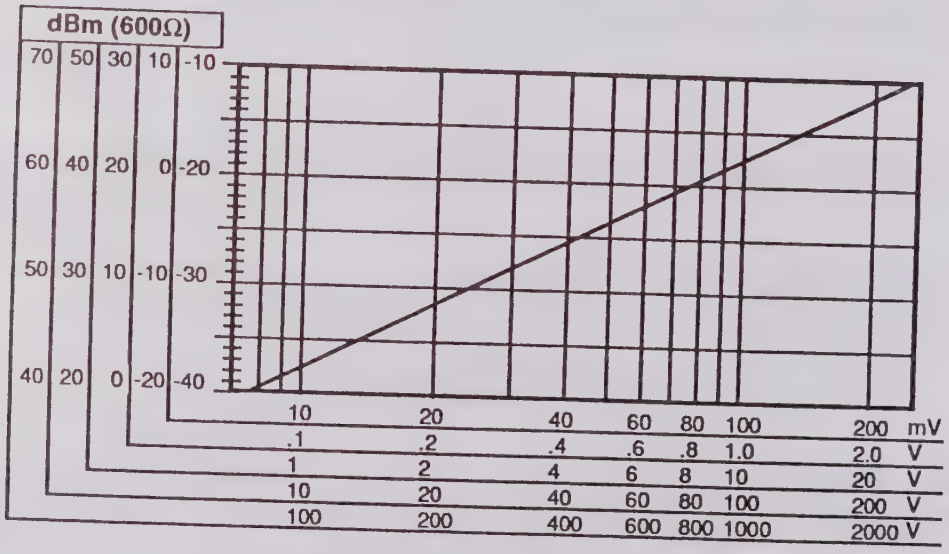
4.5 Decibel Measurements

In the audio and telephone industries, 0 dBm is defined as one milliwatt dissipated into a 600 Ohm load. Your multimeter can be used to measure audio power in dBm. First, measure the AC voltage across the load. Then use the chart below to convert the voltage reading to an equivalent reading in dBm (600Ω).

Frequency response is : *45Hz–1kHz for 222F, 223F*
(45Hz–2kHz for HD153)

The dBm chart gives an approximation of the dBm (600Ω) value. If necessary, use the following formula to obtain a more precise figure:

$$\text{dBm (600}\Omega\text{)} = 20 \times \text{Log} \frac{\text{Measured Voltage (in Volts)}}{.7746}$$

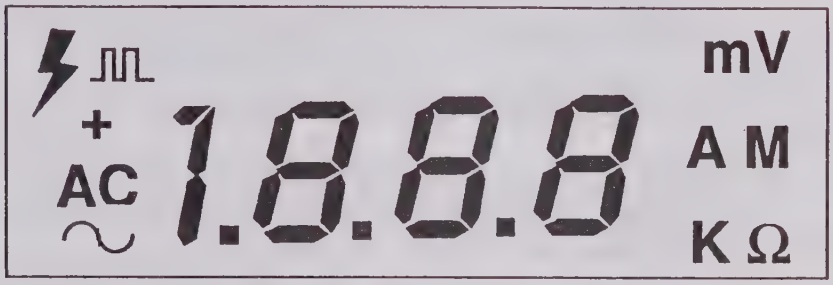


Examples: 60mV ≈ –22dBm
200mV ≈ –11.9dBm
2.5V ≈ 10dBm
5V ≈ 16dBm
30V ≈ 32dBm

Section V Maintenance

5.1 Display Test

To test the LCD display, hold the ***ON/C*** button down when turning on the meter. Verify that the display shows all segments as shown below.



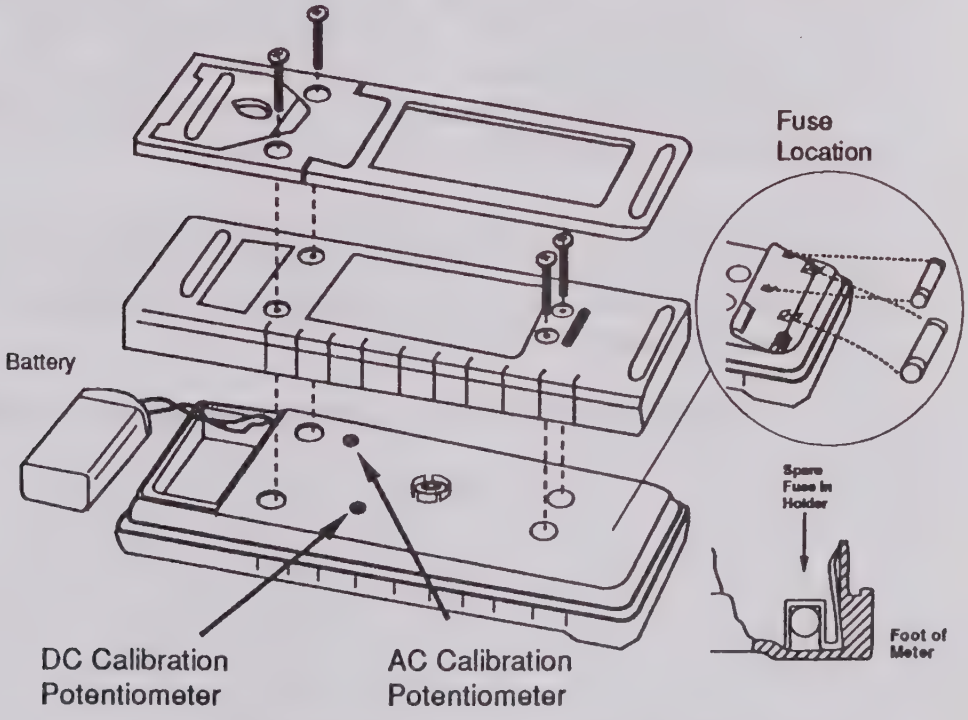


Figure 10. Exploded View of an HD153, 222F, or 223F

5.2 Battery Replacement

Replace the battery when the meter's decimal point starts blinking during normal use—indicating that less than 100 hours of battery life remains. Remove the case back (see page Figure 10, page 27) and replace the battery with a type NEDA 1604 or equivalent 9-volt alkaline battery.

NOTE: Removal of the PCB mounting screw voids the warranty.

5.3 Fuse Replacement

The HD153, 222F, and 223F use an input protection fuse for the *mA* and *10A* inputs. Remove the case back to access the fuses as shown on page 27. Replace with the same type only:

- *10A* input (large fuse), 15A @ 600V: Littlefuse p/n KLK-15, Bussman p/n KTK-15 or Wavetek p/n FG3000-400-214
- *mA* input (small fuse), 0.25A @ 600V: Wavetek p/n FP360.

A spare small fuse (0.25A @ 600V) is provided inside the meter's case (Figure 10). Reorder this part from the factory.

Caution: To ensure safe operation, you must replace the 0.25A/600V fuse with the above part number or equivalent. You must also reinstall the spare fuse container when installing the spare fuse to prevent its coming loose and causing a short circuit.

NOTE: Removal of PCB mounting screw voids the warranty.

5.4 Calibration (see Figure 10, page 27, for location of controls)

Note: Meter should be calibrated yearly by a qualified technician. For best accuracy, ambient conditions must be 25°C ±2°, <80% RH during calibration.

1. Remove case back (see page 27). Turn meter ON and select ***V*** ⎓
2. Apply +1.900 VDC ±0.0001V to *V*-Ω input (negative to *COM*).
3. Adjust DC calibration pot through hole in PCB for +1.900V display.
4. Select ***V*** ∿.
5. Apply 1.900VAC ±0.002VAC @ 600Hz to *V*-Ω input.
6. Adjust AC calibration pot through hole in PCB for +1.900V display.
7. Reassemble meter.

5.5 Assembly Parts List

	Part Description	Part Number	153	222F	223F
1	Case, Front	3000-426-351	1	-	-
	Case, Front	3000-425-391	-	1	-
	Case, Front	3000-426-391	-	-	1
2	Overlay, Front	3000-920-543	1	-	-
	Overlay, Front	3000-920-539	-	1	-
	Overlay, Front	3000-920-540	-	-	1
3	Case, Rear	3000-420-352	1	-	-
	Case, Rear	3000-420-382	-	1	1
4	Knob, Select	3000-420-353	1	-	-
	Knob, Select	3000-420-383	-	1	1
5	Button Array	3000-452-243	-	1	-
	Button Array	3000-453-243	1	-	1
6	Bail, Tilt Yellow Ass'y	3000-571-155	1	-	-
	Bail, Tilt Grey Ass'y	3000-571-165	-	-	1
7	O-Ring Case Boss	3000-450-221	4	-	-
8	O-Ring Input Jack/Shaft	3000-450-222	5	1	1
9	Gasket, Case	3000-450-223	1	-	-
10	Fuse, 600V/.25A (F2) SML	3000-400-121	2	2	2
11	Fuse, 600V/15A (F1) LRG	3000-400-214	1	1	1
12	Retainer, Fuse	3000-420-358	1	1	1
13	PCB Display Assembly	3000-520-152	1	1	1
14	PCB Input 4J Assembly	3000-520-151	1	-	-
	PCB Input 4J Assembly	3000-520-169	-	1	-
	PCB Input 4J Assembly	3000-521-169	-	-	1
15	Rotor Ass'y w/ Contacts	3000-570-156	1	1	1
16	Contacts Spring	3000-370-352	3	3	3
17	Pad, Anti-Skid	3000-450-244	2	2	2
18	LCD	3000-390-105	1	1	1
19	Battery, 9V	3000-380-100	1	1	1
20	Pad, Battery Snap	3000-451-182	1	1	1
21	Connector, Carbon LCD	3000-370-350	1	1	1
22	Connector, Carbon PCB	3000-370-351	1	1	1
23	Beeper, Disk	3000-360-107	1	1	1
24	Spacer,Plated Chrome	3000-420-356	1	1	1
25	Bezel, LCD Liner, Gray	3000-960-143	1	1	1
26	Shield, Case Rear	3000-450-211	1	1	1
27	Shield, Case Front	3000-450-252	1	1	1
28	Screw, PCB 4-24 x 3/8"	3000-450-106	1	1	1
29	Screw, Case 4-40 x 7/8"	3000-450-247	4	4	4
30	Test, Lead Set (R+B)	3000-370-282	1	1	1
31	Manual, Service	3000-940-219	*	*	*

* Manual is not included with meters, may be ordered separately

Section VI Specifications

6.1 HD153 Specifications (25°C±5°C)

Modes of Operation

Full Autoranging
Range Lock

Mechanical

Contamination Protection .....Sealed, 5 year contamination warranty
Drop-Proof .....Up to 10 feet
Shock and Vibration .....Meets MIL-T-28800C Class II Type A
Case Material .....Fire-retardant, high impact thermoplastic

Overload Protection

DCV Ranges .....1500VDC or peak AC, any range
ACV Ranges .....>10Hz, 1000VRMS or 1500Volts peak; <10Hz, 400VDC or Volts peak
mA Input .....250mA/600V fuse (1x0.25" fast blow)
10A Range .....15A/600V fuse (Bussman KTK15, Littlefuse KLK15 or equivalent)
Resistance/Diode/Continuity Ranges .....500VDC or RMS AC

LCD Indicators

Dangerous Voltage Indicator .....LCD lightning bolt symbol in display and beeping when entering 200V, 1000V ranges

Continuity
Threshold .....150 Ohms
Visual .....In LCD
Audible .....200ms beep
Response Time .....<100ms
Test Current .....1.1mA maximum
Overload Indication ....."OL"
Low Battery Indicator .....Blinking decimal point with <100 hours of battery life remaining

Environmental

Operating Temperature ..... -15°C to 55°C
Storage Temperature ..... -40°C to 60°C
Relative Humidity ..... 0 to 80%, O°C to 55°C
Temperature Coefficient ..... <10% of applicable accuracy spec per °C (-15°C to 20°C, 30°C to 55°C)

Accessories Included

Bail with Skyhook ..... HD153 only
Spare Fuse ..... 250mA/600V inside meter
Battery ..... one 9V–NEDA 1604
Test Leads ..... one pair of right angle leads

Miscellaneous Specifications

Response Time ..... <1s (<2s for 20MΩ, 1500VDC, and 1000VAC ranges)
Display
- Digits ..... 3-1/2 digits, height: 12.5mm
- Counts 2000
- LCD Drive ..... Direct
- Update Rate ..... Five per second

Auto Power-Off ..... 1 hour after function or mode change
- Current Draw ..... Less than internal battery leakage

Calibration ..... Accuracy guaranteed for one year
Calibration Adjustments ..... DC reference & AC conversion
Safety ..... Designed to IEC348
Size
- Height 173mm
- Width 71mm
- Depth 32mm
- Weight ..... 326 grams

Battery Life ..... Alkaline: 500 hours typical
Lithium: 1000 hours typical

Functional Specifications

	HD153
DC Voltage	
Ranges	200m, 2, 20, 200, 1500
Resolution	100µV
Accuracy	0.25% + 1 count (1.5kV range: 0.4%)
Input Impedance	10MΩ
NMRR	>60dB at 50Hz and 60Hz
CMRR	>140dB up to 1500VDC
AC Voltage	
Ranges	200m, 2, 20,200,1000
Resolution	100µV
Accuracy	
(45—1kHz)	0.75%+3 counts+300µV
(1kHz—2kHz)	2.0%+7 counts+300µV
Conversion Type	Average sensing RMS indicating
Input Impedance	10MΩ shunted by <100pF
Resistance (Ω)	
Ranges	200, 2k, 20k, 200k, 2M, 20M
Resolution	0.1Ω
Accuracy	0.5% + 2 counts
20MΩ range	1.5% + 2 counts
Max Open Ckt V	6.5VDC
Max In-Range V	200mV (20MΩ range: 2V)
Max Test Current	1.1mA
Current (Amperes)	
Ranges (AC & DC)	20m, 200m, 10A
Resolution	10µA
DC Accuracy	
Ranges <10A	0.75% + 1 count
10A Range	1.5% + 1 count
AC Accuracy	
45Hz—1kHz	
20m/200m Ranges	1.5% + 2 counts
10A Range	2.0% + 2 counts

Functional Specifications (continued)

	HD153
Current (Amperes)-*continued*	
AC Conversion Type	Average sensing
Max Voltage Burden	
20mA Range	15mV/mA
200mA Range	15mV/mA
10A Range	0.04V/A
Diode Test	
Range	2V
Resolution	1mV
Accuracy	1.0% + 1 digit
Test Current	1mA ±1% at < 1.5V
Open Circuit Voltage	6.5V

HD153 Specifications

Audible Readout

Resolution ..... Approx. 2% of range
Speed of Response ..... <1ms

Logic Pulse Detector

Logic Levels ..... TTL, CMOS
Threshold ..... +2.6V
PulseWidth (min) 50ns
Detector ..... AC coupled
Impedance ..... 10M/100pF shunt
Pulse Rise Time (max) 10µs
Pulse Rep Rate (max) 1Mpps
Indication ..... 40ms beep

6.2 222F and 223F Specifications (25°C±5°C)

Modes of Operation

Full Autoranging
Range Lock

Mechanical

Shock and Vibration ..... Meets MIL-T-28800C Class 2 Type A

Overload Protection

DCV and Logic Ranges ..... 1000VDC or peak AC, any range
ACV Ranges ..... >10Hz, 750VRMS or 1000Vpk;
<10Hz, 400VDC or Vpk
mA Input ..... 250mA/600V fuse (1x0.25" fast blow)
10A Range ..... 15A/600V fuse (Bussman KTK15,
Littlefuse KLK15 or equivalent)
Resistance/Diode/Continuity Ranges ..... 500VDC or RMS AC

Indicators

Dangerous Voltage Indicator ... LCD lightning in display and beeping
when entering 200V, 1000V ranges
Continuity Indicator
Threshold ..... 150 Ohms
Visual ..... In LCD
Audible ..... 200ms beep
Response Time ..... <100ms
Test Current ..... 1.1mA maximum
Overload Indication ..... "OL"
Low Battery Indicator ..... Blinking decimal point with <100 hours of
battery life remaining

Environmental

Operating Temperature ..... -15°C to 55°C
Storage Temperature ..... -40°C to 60°C
Relative Humidity ..... 0 to 80%, O°C to 55°C

Environmental (Cont'd)

Temperature Coefficient .....<10% of applicable accuracy spec per °C
(-15°C to 20°C, 30°C to 55°C)

Accessories Included

Bail with Skyhook .....Model 223 only
Battery .....one 9V–NEDA 1604
Test Leads .....one pair of right angle leads

Miscellaneous Specifications

Response Time ....<1s (<2s for 20MΩ, 1000VDC, & 750VAC ranges)
Display
Digits .....3-1/2 digits, height: 12.5mm
Counts 2000
LCD Drive .....Direct
Update Rate .....Five per second
Auto Power-Off .....1 hour after function or mode change
Current Draw .....Less than internal battery leakage
Calibration .....Accuracy guaranteed for one year
Calibration Adjustments .....DC reference & AC conversion
Size
Height 173mm
Width 71mm
Depth 32mm
Weight .....326 grams
Battery Life .....Alkaline: 500 hours typical
Lithium: 1000 hours typical

Functional Specifications

	Model 223F	Model 222F
DC Voltage		
Range	200m, 2, 20, 200, 1000	200m, 2, 20, 200, 1000
Resolution	100µV	100µV
Accuracy	0.25% + 1 count (1kV range: 0.4% + 1 count)	0.5% + 1 count
Input Impedance	10MΩ	10MΩ
NMRR	>60dB at 50Hz or 60Hz	>60dB at 50Hz or 60Hz
CMRR	>140dB up to 1000VDC	>140dB up to 1000VDC
AC Voltage		
Ranges	200m, 2, 20,200,750	200m, 2, 20,200,750
Resolution	100µV	100µV
Accuracy (45Hz—1kHz)	2.0% + 2 counts	2.0% + 2 counts
Conversion Type	Average sensing RMS indicating	Average sensing RMS indicating
Input Impedance	10MΩ shunted by <100pF	10MΩ shunted by <100pF
Resistance (Ω)		
Ranges	200, 2k, 20k, 200k, 2M, 20M	200, 2k, 20k, 200k, 2M, 20M
Resolution	0.1	0.1
Accuracy	0.5% + 2 counts (1.5% + 2 counts–for 20MΩ range–2.0% + 2 counts)	0.7% + 2 counts
Max Open Ckt V	6.5VDC	6.5VDC
Max In-Range V	200mV (20MΩ range: 2V)	200mV (20MΩ range: 2V)
Max Test Current	1.1mA	1.1mA
Current (Amperes)		
Ranges (AC & DC)	20m, 200m, 10A	20m, 200m, 10A
Resolution	10µA	10µA
DC Accuracy		
20m/200 Ranges	0.75% + 1 count	1.0% + 1 count
10A Range	1.5% + 1 count	1.5% + 1 count
AC Accuracy (45Hz—1kHz)		
20m, 200m,10A	3.0% + 2 counts	3.0% + 2 counts
AC Conversion Type	Average sensing	Average sensing
Voltage Burden		
20mA Range	20mV/mA	20mV/mA
200mA Range	20mV/mA	20mV/mA
10A Range	0.02V/A	0.02V/A

Functional Specifications (continued)

Diode Test	Model 223F	Model 222F
Range	2V	2V
Resolution	1mV	1mV
Accuracy	1.0% + 1 count	1.0% + 1 count
Test Current	1mA ±1% @ < 1.5V	1mA ±1% @ < 1.5V
Open Circuit Voltage	6.5V	6.5V

Model 223F Specifications

Audible Readout

Resolution ..... Approx. 2% of range
Speed of Response ..... <1ms

Logic Pulse Detector

Logic Levels ..... TTL, CMOS
Threshold ..... +2.6V
Pulse Width (min) 50ns
Detector ..... AC coupled
Impedance ..... 10M/100pF shunt
Pulse Rise Time (max) 10µs
Pulse Rep Rate (max) 1Mpps
Indication ..... 40ms beep

Section VII Service

Factory Service

Read the warranty located at the front of this manual before requesting warranty or non-warranty repairs.

Shipping Instructions

For in- and out-of-warranty repairs in the United States, we recommend shipping your multimeter to the factory for repair. Our factory service center features 24-hour turnaround time under normal circumstances, with a maximum of 48 hours guaranteed. Combined with low flat rate charges and fast turnaround time, the factory service center provides your best overall service alternative. (If you wish to utilize a local service facility, a list of authorized service centers in the United States can be found on the following pages.) A multimeter returned for calibration or repair should be shipped with the following: your company name (if applicable), your name, address, telephone number, proof of purchase (for warranty repairs), and any test leads used with the meter. In addition, make sure to **include a written description of the problem encountered or service required. For minimum turn-around time on out-of-warranty repairs please phone in advance for service-charge rates. Ship the multimeter with test leads in a sturdy box to the following address and marked *Attention: Instrument Repair/ Service***:

For U.S.A.:	**For U.K.:**	**For Canada:**
Wavetek Corporation	Wavetek Ltd.	(Refer to Service
9045 Balboa Ave.	Hurricane Way	Centers-Canada
San Diego, CA 92123	Norwich, NR6 6JB, U.K.	on the following pages.)
Tel: (619) 279-2200 ext. 670	Tel: 011-44-603-404824	
800-223-9885	Fax: 011-44-603-483670	
Fax: (619) 495-3296		

The multimeter will be returned with the shipping charge paid by Wavetek Corp. For questions in North America, contact the Instrument Repair & Service Department at (619) 279-2200 ext. 670.

Service and Shipping Instructions for Other Countries
Contact your local Wavetek Corp. dealer or distributor where the multimeter was purchased or refer to the *Service Centers - Other* list on the following pages.

See previous page for factory service center address. If local service is necessary, the following centers are authorized to repair Wavetek Corp. Instruments.

Service Centers – U.S.A.

Alabama

Arnolds Instrumentation
3258 Spring Hill Road
Mobile, AL 36607
(205) 478-3230

California

Wavetek
Instruments Division
9045 Balboa Ave.
San Diego, CA 92123
(619) 279-2200 Ext 670
800-223-9885
Fax: (619) 565-7942

Standard Meter Labs
236 Rickenbacher Circle
Livermore, CA 94550
(415) 449-0220

Colorado

Instrument Repair Labs
2100 W. 6th Avenue #A
Broomfield, CO 80020
(303) 469-5375

R&R Instruments
15701 E. 1st Ave., Unit 106
Aurora, CO 80011
(303)364-8325

Georgia

Peach State Instruments
869-1 Pickens Industrial Drive
Marietta, GA 30062
(404) 424-0447

Illinois

Metermaster, Inc.
2055 Army Trail Rd., Suite 134
Addison, IL 60101
(708) 268-8100

Indiana

Electro Lab Services
1302 N. Fulton Avenue
Evansville, IN 47712
(812) 423-5211

Louisiana

Industrial Instrument Works
5745 Salmen Avenue
Harahan, LA 70123
(504) 733-8355

Maryland

EIL Instruments
10 Loveton Circle
Sparks, MD 21152
(301) 771-4800

Massachusetts

Cal-Tek
20 Republic Road
N. Billerica, MA 01862
(508) 667-8541

EIL Instruments
21 'A' Street
Burlington, MA 01803
(617) 272-9450

Minnesota

Instrumentation Services
957 Winnetka Avenue North
Minneapolis, MN 55427
(612) 544-8916

Missouri

Industrial Service Labs
1530 Page Industrial Blvd.
St. Louis, MO 63132
(314) 423-3141

New York

EIC Electronics
85 Avenue East
Rochester, NY 14621
(716) 544-4392

EIL Instruments
9020 Wehrle Drive
Clarence, NY 14031
(716) 634-8500

Instrument Mart
295 Community Drive
Great Neck, NY 11021
(516) 487-7430

Oklahoma

Central Instrument Labs
3158 S. 108th E. Avenue
Tulsa, OK 74146
(918) 622-0114

Ohio

Unitek
865 Cleveland Avenue
Columbus, OH 43201
(614) 291-9909

Oregon

Westcon, Inc.
5101 N. Interstate Avenue
Portland, OR 97217
(503) 283-0132

Pennsylvania

EIL Instruments, Inc.
701 Rodi Road
Pittsburgh, PA 15235
(412) 823-2255

Sunshine Instruments, Inc.
1810 Grant Avenue
Philadelphia, PA 19115
(215) 673-5600

Texas

EIL Instruments
7385 Ashcroft Street
Houston, TX 77081
(713) 271-3100

Metermaster, Inc.
3405 Express Drive
Garland, TX 75041
(214) 271-5671

Meters & Instruments
6428 Gulf Freeway
Houston, TX 77023
(713) 644-1631

Washington

EIL Instruments
2883 152nd Avenue NE
Redmond, WA 98052
(206) 882-3222

Service Centers – Canada

Alberta

Kingsway Aviation
4238 91 'A' Street
Edmonton T6E 5V2
(403) 463-5264

British Columbia

Miller Instruments
3871 N. Fraser Way, Unit 1
Burnaby V5J 5G6
(604) 431-8882

Manitoba

Probe Industrial Electronics
1874 Portage Avenue
Winnipeg R3J 0H2
(204) 885-9320

Ontario

BCS Electronics
855 Matheson Blvd E, Unit 6
Mississauga L4W 4L6
(416) 602-8550

Quebec

Projean Ltd.
1332 Rue Belanger East
Montreal H2G 1A1
(514) 273-8331

Primo Instruments
11235 Boul. L'Archeveque
Montreal-Nord H1H 3A8
(514) 329-3242

Service Centers – Other

Angola

Technidata Ltd.
P.O. Box 1619
Rua Reverendo Agostinho Pedro
Neto 21-21A
LUANDA
Tel: 32025/32309 Tlx: 3019

Argentina

Reycom Electronica SRL
Uruguay 362 Peso 8-Depto. F
1015 BUENOS AIRES
Tel: 54-1-11-1722
Fax: 54-1-11-1721

Australia

Bell-IRH Industries PTY
Warburton Franki Div.
32 Parramatta Road
LIDCOMBE, NSW2141
Tel: 61-02-648-5455
Fax: 61-02-647-1545

Austria

LICO - GmbH
Felbigergasse 38
A-1140 WIEN
Tel: 0222-940621 Tlx: 133378
Fax: 0222-944174

Bahrain

Al-Jishi Corporation
P.O. Box 617
Al-Khalifa Road
MANAMA
Tel: 253297 Tlx: 8371

Belgium

Mecotronic SA/NV
Nieuwelaan 58
1860 MEISE
Tel: 02-269 07 48 Tlx: 65602
Fax: 02-2699455

Brazil

Sistronics Instrumentacao E
Sistemas LTDA
Av Alfredo Agidio de Souza
Aranha 75-4 Andares
Jd. Santo Antonio
CEP 04726 Sao Paulo, SP

East Europe

Technology International
20 Haymarket Terrace
EDINBURGH EH12 5JZ
SCOTLAND, UK
Tel: 031-3467050 Tlx: 727563
Fax: 031-3467065

Denmark

Instrutek-Periferi AS
Christianholmsgade
DK 8700 HORSENS
Denmark
Tel: +45-75-61-11-00
Fax: +45-75-61-56-58

Egypt

Etico Scientific
3 Ahmed Heshmat Street
P.O. Box 1653
Zamalek
CAIRO
Tel: 403041/407733 Tlx: 93382

Finland

Dualtek OY
P.O. Box 63
SFO2201 ESPOO
Tel: 358-0-452621
Fax: 358-0-45262261

France

BI-Wavetek SARL
IBis Ave du Coteau
93220 GAGNY
Tel: (01) 43027606 Tlx: 212971
Fax: (01) 43817252

Germany

Wavetek GmbH
Freisinger Strasse 34
D-8045 ISMANING
Tel: (089) 9609490
Fax: (089) 967170

Greece

Micronics Ltd.
46 Kritis Street
16451 Argyrouspolis, ATHENS
Tel: 301-9914786 Tlx: 216574
Fax: 301-9951814

Iran

Zeefax Ltd., Zeefax House
320 King Street
LONDON W6 ORR
Tel: 441-7487808 Tlx: 8813278
Fax: 441-7487188

Ireland

Neltronics Ltd.
John F. Kennedy Road
Naas Road
DUBLIN 12
Tel: 503560 Tlx: 24837
Fax: 552789

Israel

Appletec Ltd
2 Hamsager St., Beit Tiran
Unit 210
Ra'anana 43653
Tel: 972-52987350
Fax: 972-52443523

Italy

Beckman Industrial Componenti Srl
Via Arese 11
20159 MILANO
Tel: 392-6888951, Tlx: 330484
Fax: 392-6896995

Jordan

Scientific & Medical
Supplies Co. P.O. Box 1387
AMMAN
Tel: 962-6-24902, Tlx: 21456
Fax: 962-6-628258

Kuwait

AZ Trading Co.
P.O. Box 25752
Jaber Al-Mubarak Street
SAFAT
Tel: 965-2-442208, Tlx: 22707

Lebanon

Elco Ltd.
P.O. Box 136
ANTELIAS
Tel: 961-894420, Tlx: 22867

Malta

Fabian Enterprises
20, Msida Road
GZIRA
Tel: 356-513283, Tlx: 1837

Mexico

Dicopel SA
Francisco Pimentel 98
Col San Rafael
Delagacion Cuautemol
06470 MEXICO D.F.
Tel: 5-705-74-22
Fax: 5-703-17-72

Dinamica Inst. SA de CV
San Diego #25 Fracc Capistrano
54500 Aticapan de Zaragoza
Edo de MEXICO
Tel: 5-361-39-12
Fax: 5-398-41-83

Morocco

Sicotel AS
Complexe Commercial Des Harbous
Tour C, 3éme Etage
Ave Des Forces
Armées Royales,
CASABLANCA 01
Tel: 010-212-312270
Tlx: 27604M
Fax: 010-212-316545

Netherlands

Air Parts International BV
Kalkovenweg 12
2401 LK ALPHEN
AAN DEN RIJN
Tel: +31-1720-43221
Fax: +31-1720-20651

Norway

Hellermann Haugerud A/S
Sandakerveien 110
0483 OSLO 4
Tel: 47-2-156012, Tlx: 18469
Fax: 47-2-156129

Oman

Photocentre Comcent
P.O. Box 3115 (Ruwi)
MUSCAT
Tel: 968-773948 Tlx: 3499

Portugal

Decada, Equipamentos
Electronicos Lda
Miraflores, Lote 102-B Alges
LISBOA 1495
Tel: 351-1-4103420 Tlx: 15515
Fax: 351-1-4101844

Qatar
Qatar Trading Co.
P.O. Box 51
DOHA
Tel: 974-323773 Tlx: 328642
Fax: 974-328642

Saudi Arabia
Mejdaf Establishment
P.O. Box 2002
RIYADH 11451
Tel: 4013206/4055240
Fax: 4630048 Tlx: 202787

South Africa
Bowthorpe Hellermann Deutsch Ltd.
80 Mimetes Rd, Denver 2094
P.O. Box 27063, Benrose 2011
JOHANNESBURG
Tel: 11-6161960, Tlx: 4-28237
Fax: 11-6164715

Spain
ESSA Equipos y Sistermas SA
Apolonio Morales, 13-B
28036 MADRID
Tel: +34-1-3590088 Tlx: 42615
Fax: +34-1-3590298

Sweden
Q Instrument AB
P.O. Box 515, S-145
63 NORSBORG
Tel: 0753-86155
Fax: 0753-84414

Switzerland
Gould Elektronik AG
Einsiedelstrsse 535
810 HORGEN
Tel: +41-1-7260000
Fax: +41-1-7260788

Syria
Far-Tou Representation
Place de l'Etoile P.O. Box 2657
29 Rue Parlement
DAMASCUS
Tel: 963-11-222261
Tlx: 411319

Tanzania
International Services Ltd.
Makunganya Street
P.O. Box 5120
DAR ES SALAAM
Tel: 01-30778, Tlx: 41312

Tunisia
Tunisie Electronique Sarl
31 Avenue de la Liberté
1002 TUNIS - Belvedere
Tel: 01-280144, Tlx: 13238

Turkey
Turkelek Elektronik Co. Ltd.
Hatay Sokak 8
ANKARA
Tel: 189483, Tlx: 42120

United Arab Emirates
Scientechnic
P.O. Box 325
DUBAI
Tel: 971-4-4666000, Tlx: 46072
Fax: 971-4-4666176

United Kingdom
Wavetek Ltd.
Hurricane Way
NORWICH, NR6 6JB
Tel: 011-44-603-404824
Fax: 011-44-603-483670

Venezuela

ONIMEX CA
2 Av. entre 3 y 4 Calles #42-13
Quinta Onimex
LOS PALOS GRANDES
Tel: 2-285-86-41
Fax: 2-285-84-17

Zimbabwe

BAK Electrical Holdings Ltd.
30 Pioneer Street
HARARE
Tel: 707601, Tlx: 2343

Wavetek Corporation
Instruments Division
9045 Balboa Ave.
San Diego, CA 92123
Tel: (619) 279-2200
800-223-9885
Fax: (619) 565-7942